FORUM

Climate change and the spread of infectious ideas[1]

As a rule, ecologists tend to leave controversy and mud-slinging to the politicians. Occasionally, however, issues arise that are so contentious that those working in the field become embroiled in vigorous debate, and positions can become entrenched. A classic example of this was the argument over the relative importance of density-dependent and density-independent limitation of population numbers. Of course, most ecologists now agree that both processes can be important and that we will gain a fuller understanding of why population numbers fluctuate the way they do only by looking at the interaction between intrinsic and extrinsic factors. The focal Concepts and Synthesis paper for this Forum, by K. D. Lafferty, looks set to spark another heated debate amongst ecologists.

Ever since climate change has been on the scientific and political agenda, researchers have been forecasting major impacts on the global distribution and prevalence of infectious diseases. The rationale for this prediction is simple: the geographical ranges of most species, including many vectors of infectious diseases, are constrained by their climate tolerances (especially temperature); as climate change is likely to expand the range of areas potentially suitable for habitation, so we should expect to see changes in the geographical distribution of infectious diseases and their vectors. The idea that infectious diseases will expand their ranges under climate change is intuitively appealing and has spread. As a consequence, the scientific literature in this field has grown rapidly, with more than 4000 papers being published in 2008 alone. Indeed, a number of high-profile papers published over the past 10–15 years have provided compelling evidence that global climate change has resulted in an increase in a number of infectious diseases, ranging from malaria in humans to fungal infections of amphibians. In his Concepts and Synthesis paper, however, Lafferty argues that the situation is more complicated than many authors have appreciated and that very different predictions will emerge with a deeper understanding of the complexities constraining species distributions and host–parasite interactions. Lafferty questions whether we really should expect to see a net increase in infectious disease prevalence, rather than simply a shift in their distributions, especially for vector-transmitted and water-borne human infections. Indeed, he argues that because past or ongoing disease control efforts have eliminated or reduced many widespread infectious diseases from developed countries, any climate-induced shifts of infectious diseases into these areas are likely to be thwarted by renewed or existing control activities. As a consequence, Lafferty suggests that we might even see a net reduction in the ranges of some infectious diseases.

A key motivation in commissioning the papers comprising this Forum was to provide a platform for the extreme and contrasting views Lafferty's paper elicited in its reviewers. The authors of these Forum papers are leading ecologists working on a range of infectious disease dynamics, with a keen interest in the effects of climate change. As a consequence, this Forum hopefully provides a fair reflection of the range of views expressed by ecologists working in this field. As might be expected from such a Forum, several of the authors take issue with a number of Lafferty's arguments. For example, Pascual and Bouma argue that, while Lafferty may be correct that we may well see no net increase in the geographical range of malaria-transmitting mosquitoes (expansions balancing retractions), this does not necessarily translate into a zero-sum change in human malaria prevalence. This is because human populations tend to be aggregated in those areas where the risk of contracting malaria is currently low, such as the highlands. If climate change makes these areas more suitable for mosquito breeding, high densities of susceptible humans will be exposed to malaria, more than offsetting the reduction in cases from areas where malaria can no longer persist. Meanwhile, Ostfeld questions Lafferty's assertion that any climate-caused increases in disease transmission potential are epidemiologically irrelevant if climate warming fails to cause R_0 to exceed 1 (R_0 is the average number of new infections resulting from a single infected host arriving in a susceptible host population and is used by epidemiologists to measure the potential for disease persistence). He argues that there are plenty of areas in Europe and North America where R_0 is projected to be less than unity, and that disease invasion may well occur if new areas are simultaneously invaded by

[1] Reprints of this 46-page Forum (including the Lafferty Concepts and Synthesis paper) are available for $10.00 each, either as PDF files or as hard copy. Prepayment is required. Order reprints from the Ecological Society of America, Attention: Reprint Department, 1990 M Street, N.W., Suite 700, Washington, D.C. 20036 (esaHQ@esa.org).

multiple infected hosts, as might happen with climate change. Many of Lafferty's examples are drawn from human infections. However, as he recognizes, because these are especially prone to the influences of management practices (e.g., drug use, vector control, health care, etc.) it may be more difficult to distinguish the impact of climate-change effects than it might be for wildlife diseases. In response, Harvell et al. argue that there is now clear evidence for a link between climate change and dramatic pathogen outbreaks in several groups of ectothermic wildlife hosts, including amphibians, shellfish, and corals.

A second reason for commissioning this Forum was the potential scope of debate that Lafferty's paper might provoke, not only from climate change and infectious disease ecologists, but also from health professionals, conservationists, and policymakers. This is because of the funding implications and political fallout that might be generated by questioning the association between climate change and infectious diseases. Indeed, Pascual and Bouma warn that it would be unfortunate if the conclusions of Lafferty's paper were mistakenly taken as providing support for the view that climate change is not important in determining large-scale changes in the geographical pattern of infectious diseases. On the other hand, Randolph cautions that exaggerated claims about the impact of climate change on future distributions of human infectious diseases can be dangerous, especially if they distract public-health agencies from effective responses directed at more important causes of disease spread. Meanwhile, Ostfeld calls for a balanced approach, making a plea that scepticism be applied equally to evidence for and against climatic effects on infectious disease. Dobson also recognizes the political dimension to the debate and argues that greater funding and capacity-building should be focused toward understanding infectious disease dynamics at a population level, perhaps at the expense of molecular-level research.

Ultimately, what stands out for me from this wide-ranging collection of papers is not so much how greatly the views of the authors differ, but how much they can agree on: (1) climate change is altering the geographical distribution and incidence of (at least some) infectious diseases and will continue to do so; (2) detecting a climate signal in disease-range changes is likely to be difficult because of the influences of other confounding factors, such as changes in land use, socioeconomic factors, vector control strategies, and health-care practices; (3) better data sets and modeling approaches are required to be able to make robust predictions of the impacts of climate change on disease dynamics; and (4) whether or not specific infectious diseases expand or contract their geographical ranges will depend not only on extrinsic factors (including climate change), but also on intrinsic factors (such as immunity, phenotypic plasticity, and evolution). However, as we have seen with previous scientific debates, it is only with informed discussion and the passage of time that we will be able to assess the relative importance of climate change and other factors in determining the changing geographical distribution of infectious diseases.

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